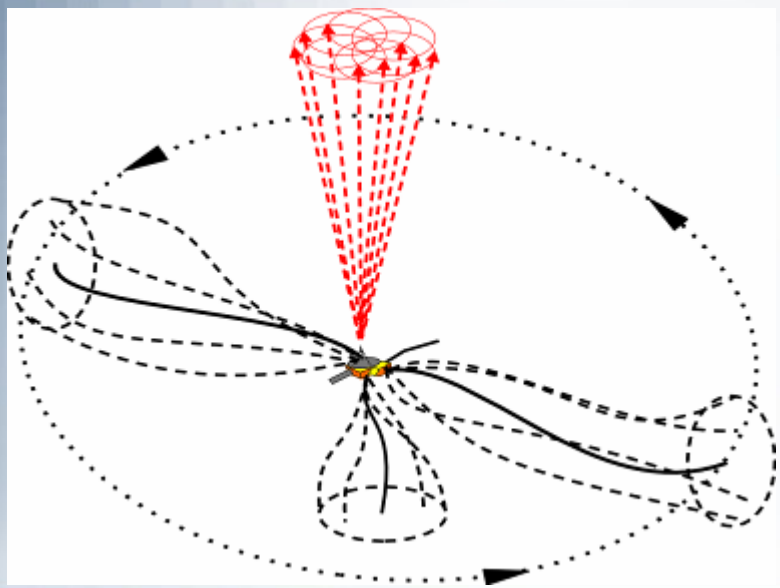
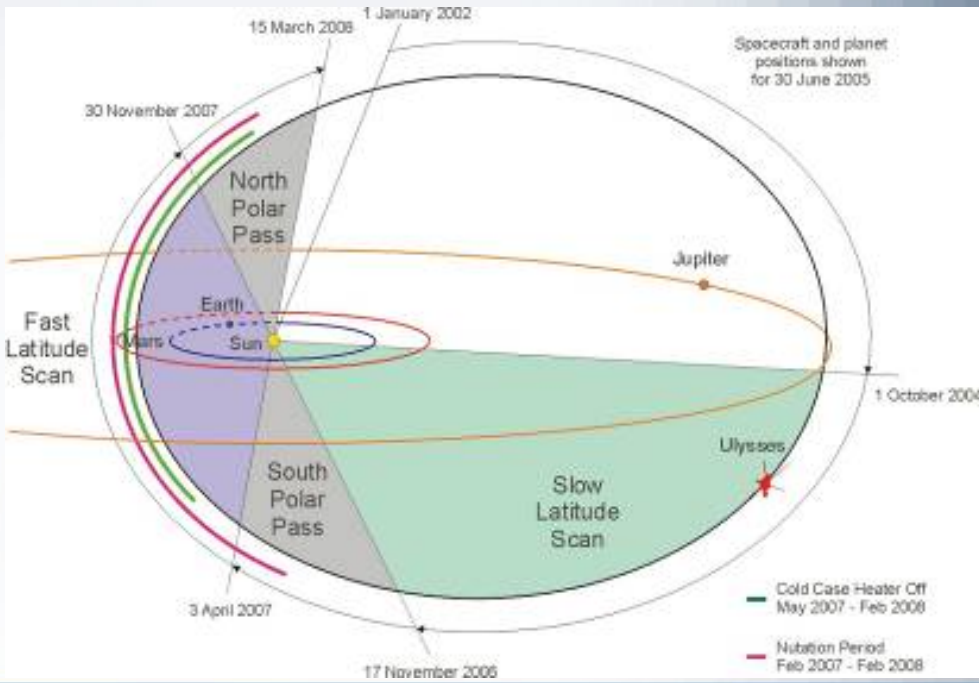
Ulysses 2007–2008 Nutation Season Supportability Study

May 2, 2006

Arthur E. Andujo





Purpose

- The purpose of this study is to determine the supportability of the Ulysses mission by the DSN during the 2007-2008 nutation season.
- Specifically this study will analyze DSN loading during the period between February 11, 2007 – March 1, 2008 and the impact to other missions.
  - Can DSN resources accommodate requests from Ulysses?
  - Can we forecast that the DSN will achieve at least 80% supportability?

Assumptions

- Mission Set From February 2006 Resource Allocation Review with the following modifications:
  - Planned launches occurring as scheduled (See Supplemental Material)
  - This study utilized a Forecast viewperiod with a 6 degree Mask (This should be noted when discussing viewperiod availability)
  - Requested support was modified to represent the actual capabilities of the DSN during the Nutation Season due to limited viewperiod and antenna downtime. (See Supplemental Material)
- DSN Assets
  - Planned downtime occurring as scheduled. (See Supplemental Material)
  - DSS-63 Hydrostatic Bearing Task Week 24 – 37 of 2007
  - DSS-45 Antenna Drive Cabinet Refurbishment 35 – 39 of 2007

Analyses

70 Meter Subnet

- Oversubscription at all 70 Meter antennas exist during most of the nutation season, and increases contention at all other subnets specifically at DSS-34. Other missions will be required to offload DSS-43 and seek support at DSS-14 and DSS-63.
- 70 Meter contention exists due to requirements supporting Cassini, DSS Maintenance, Mars' missions and Relay requirements, SOHO Keyhole and Voyager 2 as well as Ulysses.
- DSS Maintenance days will limit the support to one antenna in the daylight and Mars viewperiod at SPC 40 unless other resources can be utilized.
- The downtime scheduled for DSS-63 from week 24 – 37 of 2007 impacts supportability greatly, in that offloading from that antenna will cause contention at other resources.

34BWG1 Subnet

- High contention exists at DSS-34 due to heavy requirements for Southern hemisphere tracking, S-band uplink and Ka Band downlink requirements.
- Although supportability is higher at the 34BWG1 subnet there is still high contention caused by the maximum Ulysses viewperiod utilization.

Analyses (Continued)

Overall Supportability

- The submitted requirements are not a realistic representation of the support that the DSN can provide. The DSN cannot provide continuous coverage when there is no view of the spacecraft from the DSN.
- Supportability during the Nutation Season varies, but on the whole forecasting indicates that most of the season will be difficult to schedule.
- The minimal assets at SPC-40 and the limited Southern viewperiod are the primary reason for the low supportability.
- Other missions such as Mars and Cassini missions' requirements contribute to the contention but are also impacted by the Ulysses requirements.
- Uplink support from Madrid may not be possible due to S-Band utilization restrictions imposed by the Spanish government.
- Support from 26-Meter antennas may be available for uplink to the S/C due to SLE capabilities that have been implemented since the last nutation. However DSS-16 is no longer in service. A downlink antenna would need to be scheduled as well.

Recommendations

- Combining additional assets such as DSS-46 for Uplink and DSS-45 for downlink may help supportability and add flexibility to the mission.
- Look to other non-DSN assets such as Parkes, Perth and New Norcia for additional support particularly when the SPC-40 24-hour viewperiod is decreased and there is no view from SPC-10 or SPC-60.
- Spanish Government restrictions pose serious uplink nutation control problems. Kourou or other non-DSN assets could provide some support.

Summary of Results

Mission Supportability

- At this time the supportability for the mission during the first half of the season, weeks 7 – 34 of 2007 averages about 68%.
- In the second half supportability averages about 81%.
- Note that the forecast results do not account for the difficulty in fulfilling the minimum and maximum pass separation requirements specified by the project. This requirement can increase contention and reduce the above figures from 10% to 15%.
- The requested support from the mission cannot be fully supported by the DSN because DSN antennas cannot view the spacecraft. Thus, the request was modified to utilize all available viewperiod. The result still has contention from other users.

Summary of Results (Continued)

Decreased Supportability

- Low supportability in the first half of the season is primarily due to view of the spacecraft is limited to SPC-40.
  - Limited resources at SPC-40 highly contribute to the low supportability.
- In some periods DSN assets have no view of the spacecraft during the day that are longer than the maximum separation of the passes.
- As Viewperiod increases from SPC-10 and 60 supportability also increases.
- Overall 70-Meter subnet contention from other DSN users, particularly Mars missions is higher than at the 34BWG1 subnet.

The Results Of This Study Are Subject To Change, In That Network Loading Changes, As Requirements For Planned Missions Are Input And Updated And Periods Of Antenna Downtime Are Identified.

Supplemental Material

Resource Allocation Planning Service (RAPS)

Jet Propulsion Laboratory
California Institute of Technology

Figure 1 – Combined Supportability During Nutation

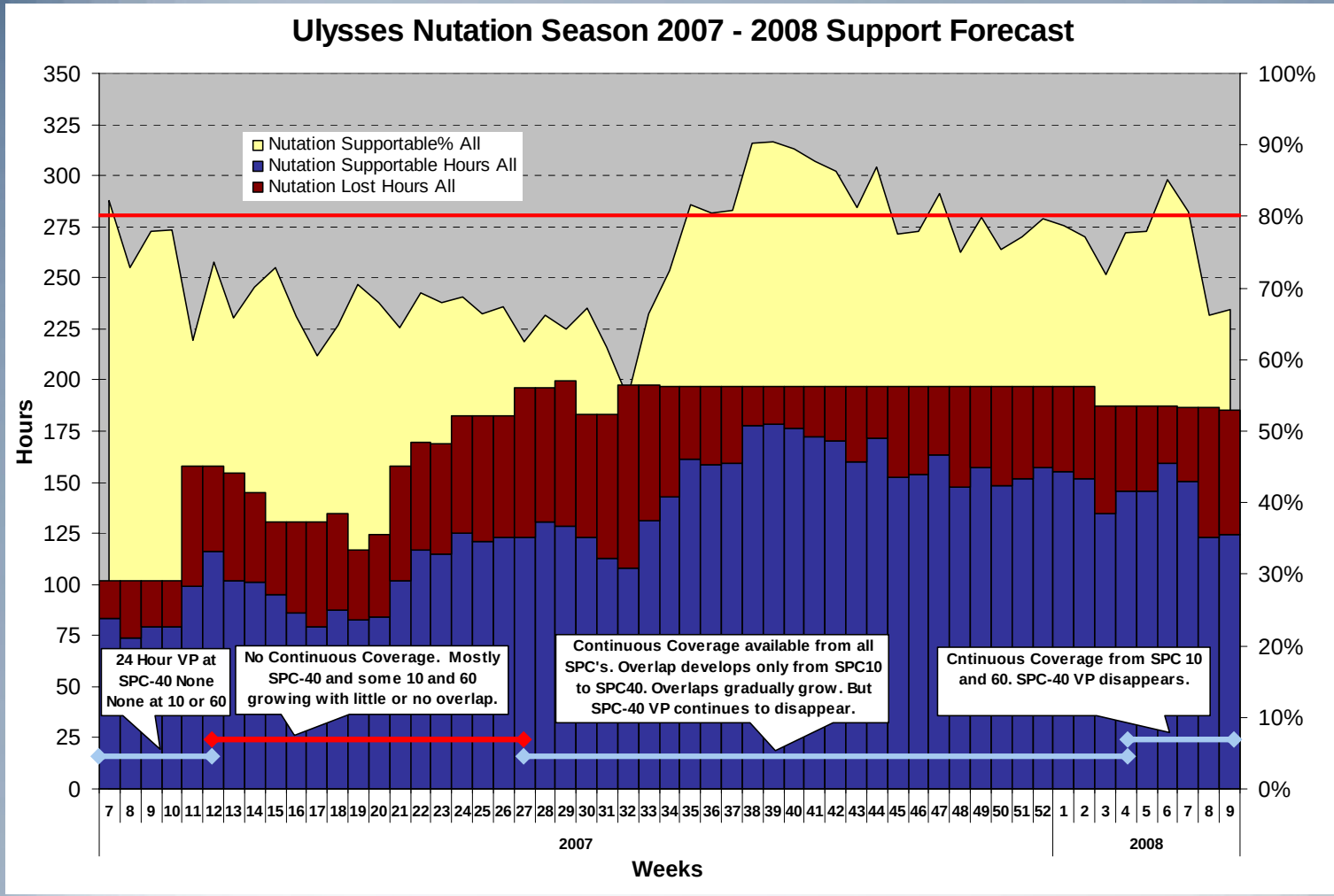


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Figure 2 – 70 Meter Subnet Supportability During Nutation

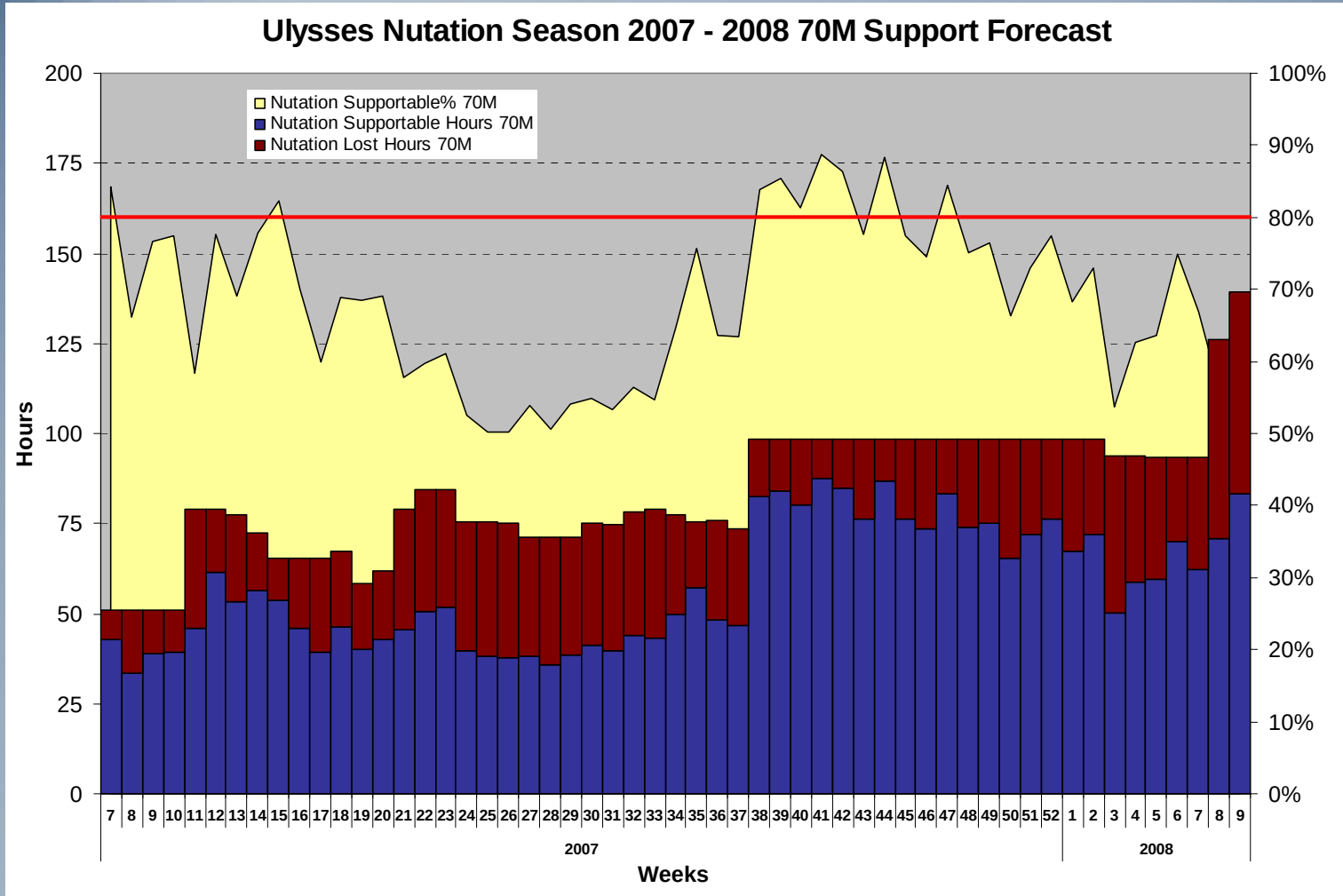

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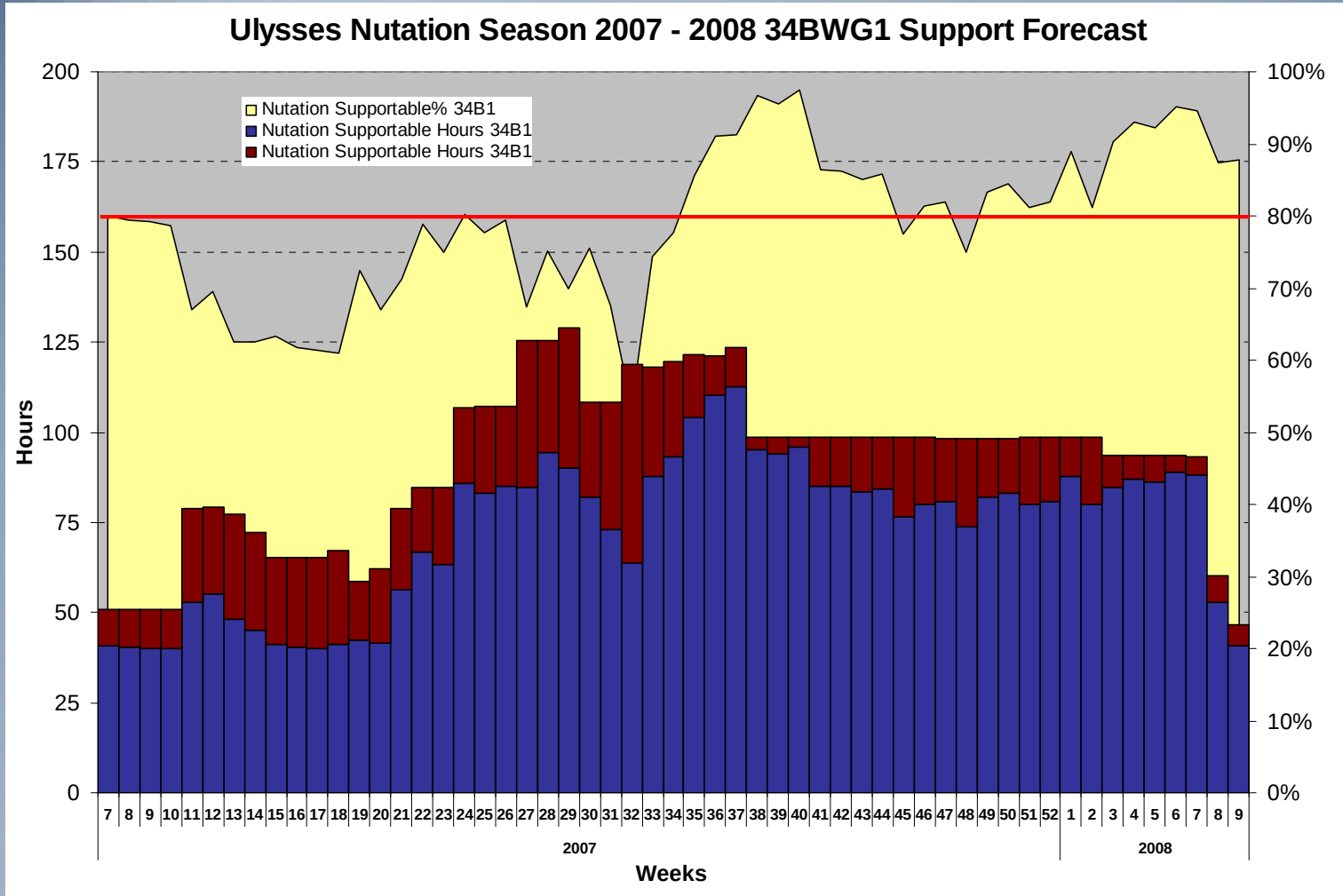
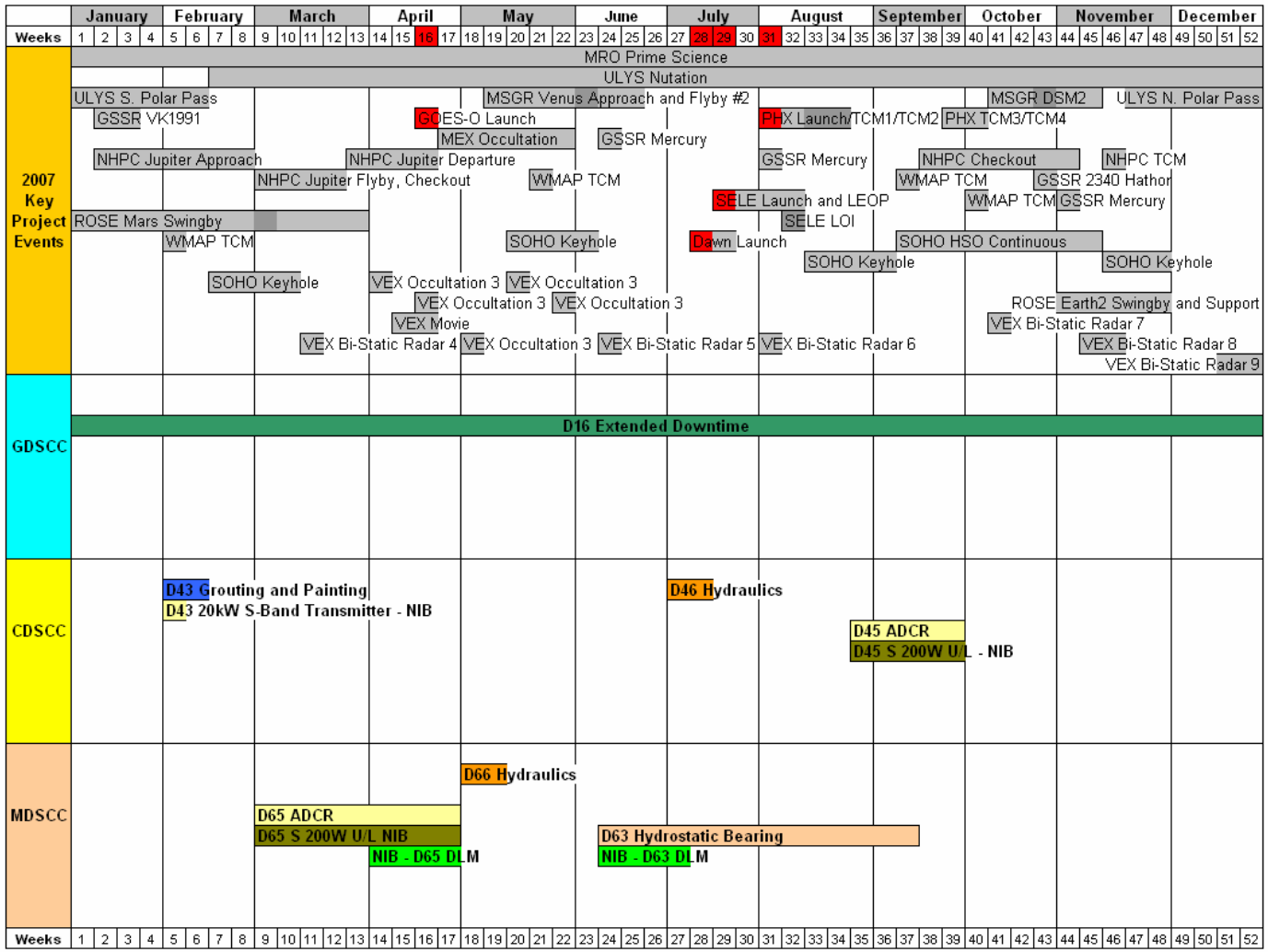
Figure 3 – 34BWG1 Subnet Supportability During Nutation



Resource Allocation Planning Service (RAPS)

Figure 4 – Major DSN Downtimes and Mission Events 2007



Revised: May 2, 2006

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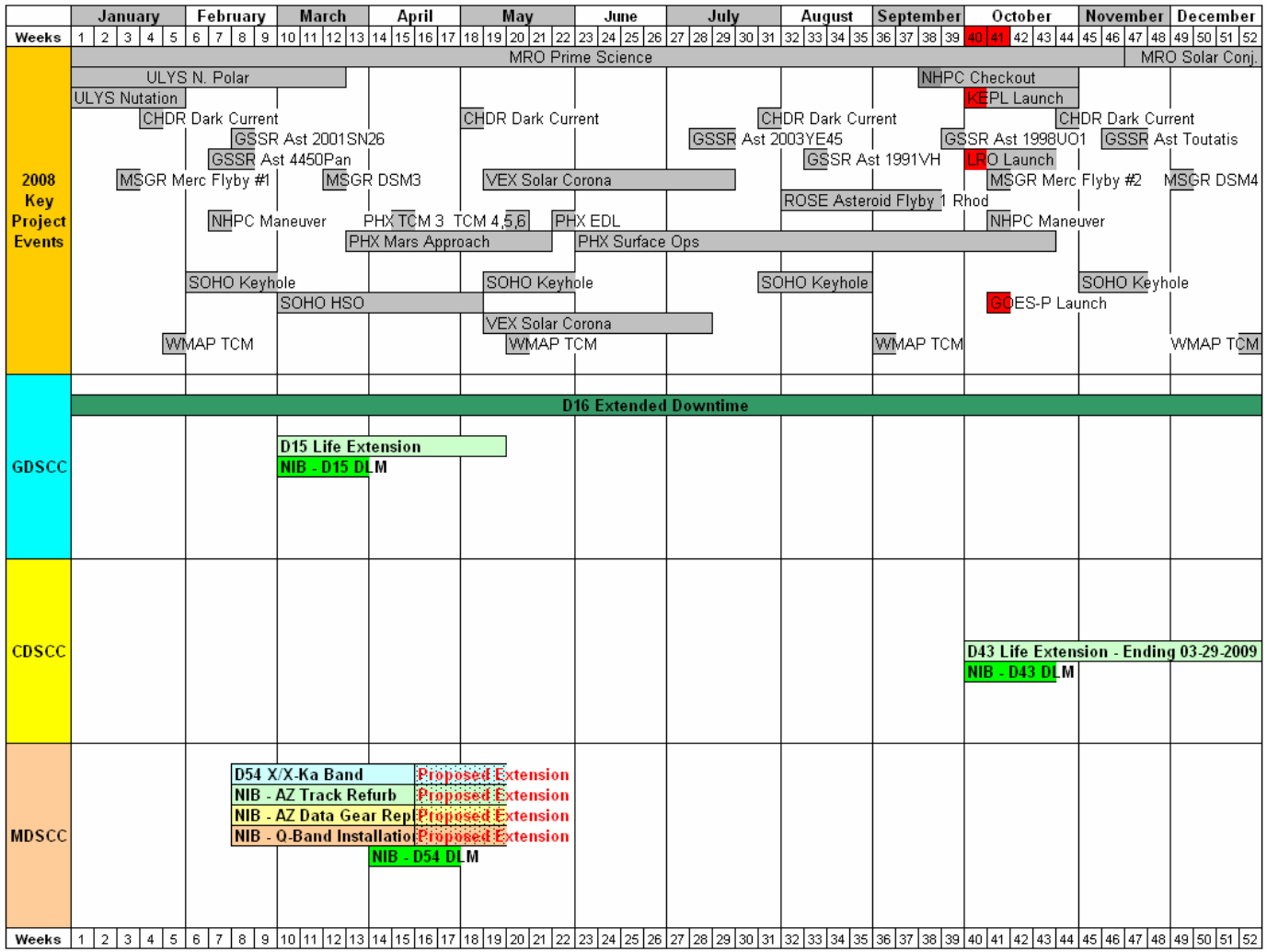
Figure 5 – Major DSN Downtimes and Mission Events 2008



Revised: May 2, 2006

Figure 6 – Modified Ulysses User Loading Profile for 2007 – 2008

28-Apr-06

User Loading Profiles

Concurrence:

Project Manager Date

Ulysses Requested Support for 2007 - 2008

VP Object	User	Resource	Durations Ave	Min	Calibration Pre	Post	January	February	March	April	May	June	July	August	September	October	November	December
							1 2 3 4 5	6 7 8 9	10 11 12 13	14 15 16 17	18 19 20 21 22	23 24 25 26 27	28 29 30 31	32 33 34 35	36 37 38 39 40	41 42 43 44	45 46 47 48	49 50 51 52 53
2007																		
ULYS	ULYS Nutation	S-14,24,34,43,54	8.0	4.0	1.00	0.25								21 21 21 21 21 21				
ULYS	ULYS Nutation	14,24,34,43,54,63	6.0	6.0	1.00	0.25		14 14 14 14										
ULYS	ULYS Nutation	DSS-14,24	6.0	4.0	1.00	0.25												
ULYS	ULYS Nutation	DSS-14,24,54	6.0	4.0	1.00	0.25						14 14 14	14 14					
ULYS	ULYS Nutation	DSS-14,24,54,63	10.0	4.0	1.00	0.25									14 14 14 14 14 14 14 14 14 14 14 14 14 14			
ULYS	ULYS Nutation	DSS-14,24	7.5	6.0	1.00	0.25							7 7 7					
ULYS	ULYS Nutation	DSS-14,24,54	8.0	4.0	1.00	0.25												
ULYS	ULYS Nutation	DSS-14,24	4.0	4.0	1.00	0.25					7							
ULYS	ULYS Nutation	DSS-14,24,54,63	5.0	4.0	1.00	0.25					7	14 14						
ULYS	ULYS Nutation	DSS-14,24	5.0	4.0	1.00	0.25					7							
ULYS	ULYS Nutation	DSS-54,63	4.5	4.0	1.00	0.25												
ULYS	ULYS Nutation	DSS-34,43	4.0	4.0	1.00	0.25									7 7 7 7 7 7 7 7 7 7 7 7 7 7			
ULYS	ULYS Nutation	DSS-34,43	8.0	5.5	1.00	0.25				14 14 14 12								
ULYS	ULYS Nutation	DSS-34,43	9.0	5.5	1.00	0.25			4 14									
ULYS	ULYS Nutation	DSS-34,43	10.0	6.0	1.00	0.25			14 14 10		2 7 7 6 7	7 7 7 7	7 7 7 7 7					
ULYS	ULYS Nutation	DSS-34,43	5.5	5.5	1.00	0.25												
ULYS	ULYS Nutation	DSS-54	6.5	6.0	1.00	0.25							7 7					
ULYS	ULYS Nutation	DSS-54	7.0	6.5	1.00	0.25							7					
ULYS	ULYS Nutation	DSS-34,43	11.0	8.0	1.00	0.25					1							
ULYS	ULYS Nutation	DSS-54,63	4.0	4.0	1.00	0.25					6							
ULYS	ULYS Ranging	DSS-24,34	4.0	1.0	1.00	0.25	1 1		1		1	1	1	1	1	1	1	1
ULYS	ULYS Ranging	DSS-34	4.0	1.0	1.00	0.25		1		1								
ULYS	ULYS Ranging	DSS-34,43	4.0	1.0	1.00	0.25			1									
ULYS	ULYS South Polar	DSS-34,45	10.0	4.0	1.00	0.25	7 7 7 7 7 7											
2008																		
ULYS	ULYS Nutation	DSS-14,24,54,63	10.0	5.5	1.00	0.25	14 2											
ULYS	ULYS Nutation	DSS-14,24,54,63	12.0	6.0	1.00	0.25	5 14 14 14 14 14											
ULYS	ULYS Nutation	DSS-14,24,63	12.0	6.0	1.00	0.25		14										
ULYS	ULYS Nutation	DSS-14,24	12.0	6.0	1.00	0.25		7										
ULYS	ULYS Nutation	DSS-63	12.0	6.0	1.00	0.25		7										
ULYS	ULYS D/L	DSS-65	6.0	4.0	1.00	0.25			7 7 7 7									
ULYS	ULYS Nutation	DSS-34,43	4.0	4.0	1.00	0.25	7 2											
ULYS	ULYS Ranging	DSS-24,34	4.0	1.0	1.00	0.25			1									
ULYS	ULYS U/L	DSS-24	4.0	4.0	1.00	0.25			7 7 7 7									

Resource Allocation Planning Service (RAPS)

Jet Propulsion Laboratory
California Institute of Technology

Figure 7 – Submitted Ulysses User Loading Profile for 2007 – 2008

24-Jan-06

User Loading Profiles

Concurrence:

Project Manager Date

Ulysses

VP Object	User	Resource	Durations Ave	Min	Calibration Pre	Post	January 1 2 3 4 5	February 6 7 8 9 10	March 11 12 13 14 15	April 16 17 18 19 20	May 21 22 23 24 25	June 26 27 28 29 30	July 31 32 33 34 35	August 36 37 38 39 40	September 41 42 43 44 45	October 46 47 48 49 50	November 51 52 53
2007																	
ULYS	ULYS Nutation	DSS-34,43	6.0	6.0	1.00	0.25		12 13 13 14 14									
ULYS	ULYS Nutation	DSS-34,43	5.5	5.5	1.00	0.25			15 16 17 16 14 13								
ULYS	ULYS Nutation	DSS 14,24,34,43,54,63	6.0	5.5	1.00	0.25				13 12							
ULYS	ULYS Nutation	DSS 14,24,34,43,54,63	5.5	5.5	1.00	0.25				16							
ULYS	ULYS Nutation	DSS 14,24,34,43,54,63	5.0	5.0	1.00	0.25					20 22 24 26 29					26 24 23 22 19 19	
ULYS	ULYS Nutation	DSS 14,24,34,43,54,63	4.5	4.5	1.00	0.25						32 34 38 39 40 39 40 39 38 32 31	36 36 38 37 37 36 34 33 31 31 28				
ULYS	ULYS Ranging	DSS-24,34	4.0	1.0	1.00	0.25	1	1	1	1	1	1	1	1	1	1	1
ULYS	ULYS Ranging	DSS-34	4.0	1.0	1.00	0.25		1		1							
ULYS	ULYS Ranging	DSS-34,43	4.0	1.0	1.00	0.25			1								
ULYS	ULYS South Polar	DSS-34,45	10.0	4.0	1.00	0.25	7 7 7 7 7										
2008																	
ULYS	ULYS Nutation	DSS 14,24,34,43,54,63	5.5	5.5	1.00	0.25	17 17 15										
ULYS	ULYS Nutation	DSS 14,24,54,63	5.5	5.5	1.00	0.25		15									
ULYS	ULYS Nutation	DSS 14,24,54,63	6.0	6.0	1.00	0.25		14 13 13 11 12									
ULYS	ULYS D/L	DSS-54	6.0	4.0	1.00	0.25			7 7 7 7								
ULYS	ULYS Ranging	DSS-24,34	4.0	1.0	1.00	0.25				1							
ULYS	ULYS U/L	DSS-24	4.0	4.0	1.00	0.25			7 7 7 7								